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CONTRIBUTION TO THE KNOWLEDGE OF VERMETIDAE  
(MOLLUSCA: GASTROPODA) FROM THE LIGURIAN SEA \*\*

KEY WORDS: Gastropoda, Vermetidae, Taxonomy, Adaptations, Ligurian Sea

**Abstract**

Vermetidae Rafinesque, 1815 are represented in the Mediterranean Sea, by eight-nine species, often difficult to identify. Several morphological characters of the following species: *Vermetus (Vermetus) triquetrus* Bivona Ant., 1832; *Vermetus (Thylacodus) granulatus* (Gravenhorst, 1831); *Petalococonchus (Macrophragma) glomeratus* (L., 1758) and *Serpulorbis arenaria* (L., 1767) coming from some localities of Ligurian coast, have been studied in order to increase the knowledge of this family. The studies of the shell, of the opercular and radular characters, and of the colours of the living animal, have permitted a better definition of the considered species, in the framework of possible morphological ranges.

In particular, some features of *Vermetus granulatus*, which is seldom recorded in the Mediterranean Sea, are discussed, permitting its own better identification. Finally, some examples of the plasticity of this family in modifying shell structure after environmental changes or following shell damages are given.

**Riassunto**

La Famiglia Vermetidae Rafinesque, 1815 è rappresentata nelle acque italiane da otto-nove specie, spesso di difficile identificazione. Al fine di contribuire ad una sua maggiore conoscenza sono stati studiati diversi caratteri morfologici su esemplari di alcune specie: *Vermetus (Vermetus) triquetrus* Bivona Ant., 1832; *Vermetus (Thylacodus) granulatus* (Gravenhorst, 1831); *Petalococonchus (Macrophragma) glomeratus* (L., 1758) e *Serpulorbis arenaria* (L., 1767) provenienti da località della costa ligure.

Lo studio dei caratteri conchigliari, di quelli opercolari, del colore degli individui e delle caratteristiche radulari ha permesso di definire meglio le specie considerate, inquadrandole all'interno di possibili ranges morfologici. In particolare vengono ridescritti alcuni caratteri di *Vermetus granulatus*, specie raramente segnalata in Mediterraneo, che permettono una sua migliore identificazione.

Vengono infine illustrati alcuni esempi di plasticità adattativa nella conformazione del tubo in rapporto a mutate condizioni ambientali o riparazioni conchigliari dovute a rotture subite.

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## Introduction

In the Mediterranean Sea, Vermetidae Rafinesque, 1815 are represented by eight-nine species (SABELLI *et al.*, 1990-1992; BODON *et al.*, 1995), often difficult to identify because the past descriptions (MONTEROSATO, 1892) are mainly based on the shell which shows great morphological variability, being continuously exposed to environmental changes. Moreover, the taxonomic value of the shell sculpture is modest being often erased or completely modified by epibionts: sometimes, in the same specimen, different expressions of the sculpture, according to the examined point, are present.

In order to define possible morphological ranges of some species recorded in Ligurian Sea (*Vermetus* (V.) *triquetrus* Bivona, 1832; *Vermetus* (T.) *granulatus* (Gravenhorst, 1831); *Petalococonchus* (M.) *glomeratus* (L., 1758) and *Serpulorbis arenaria* (L., 1767)), a study of the main features of the shell, the operculum, the radula, and colours of the living animals, has been made, as an addition to previous studies, which were generally based on incomplete specimens. Some characters of the shell, related to environmental changes were examined.

## Material and methods

The observations and the specimen samplings have been carried out around Portofino Promontory (Ge), Pontetto (Ge), and Varigotti (Sv). Each specimen was collected by scuba-diving and removed from the rock using hammer and chisel. For each sample, depth and position (exposed or sheltered) have been noted. The samples were anesthetized with 7% MgCl<sub>2</sub> in sea water, fixed in 4% neutral formaldehyde and kept in 75% alcohol. In the laboratory, samples were cleaned removing the coarse incrustations, in order to evaluate the development of the coils and the colours of each animal noted.

If the specimen was a female with juveniles settled on the shell, the animals were bred in a jar under controlled temperatures (15°C).

Each individual was dissected using a stereo-microscope. The opercular size reported to the diameter of the aperture and sex was noted. Radula, jaws and operculum were taken out and preserved.

For SEM observations, radula, jaws and juveniles were cleaned in sodium hypochlorite and hydrogen peroxide, then critical point dried. Afterward, these structures were mounted on stubs and coated with gold in a Balzers Union evaporator. Observations were carried out with a Philips EM 515 scanning electron microscope.

## Results

Description of the stations and species distribution (Fig. 1)

Punta del Faro (Portofino Promontory) is an exposed station characterized by a cliff reaching 50 metres depth (TORTONESE, 1958; MORRI *et al.*, 1986). Besides the common *Vermetus triquetrus* and *Serpulorbis arenaria*, samples of *Vermetus granulatus* have been recorded.

Baia dei Saraceni, close to Varigotti, is rarely affected by the surf action because it is protected by the Punta Crena Promontory (FIERRO, 1974). The bottom is sandy and the depth is around 4 metres. The anemone, *Anemonia sulcata*, occurs in large populations on rocks and some outcrops of the beach-rock. *Vermetus triquetrus* and *Serpulorbis arenaria* have been recorded from this station.

Pontetto is a rocky zone close to Genova, with several big boulders near the coast. Specimens of *Vermetus triquetrus* and *Serpulorbis arenaria* were collected here, together with the unique sample of *Petalconchus glomeratus* found in the framework of this research.

In the Ligurian Sea, vermetids never form reefs as in more temperate regions (PÉRÈS & PICARD, 1964; KEMPF & LABOREL, 1968; SAFRIEL, 1974; CHEMELLO *et al.*, 1990; TEMPLADO *et al.*, 1991), and aggregations of more than ten individuals are rare. In Liguria, *V. triquetrus* was found in rocky pools and up to a depth of 3 metres. Deeper findings are sporadic. *V. granulatus* was found at 4-5 metres depth.

*S. arenarius* seems not to have any particular needs connected with depth (alive specimens were observed up to 18 metres depth), but it is always settled in sheltered places.

#### Description of the species

##### *Vermetus (Vermetus) triquetrus* Bivona Ant., 1832

Pontetto (Ge) (from June to September 1994) (8 fem. -3 ovigerous-; several males).

Portofino Promontory (Ge) (From July to September 1994) (some males).

Varigotti (Sv) (10 Aug 1994) (2 fem. non ovigerous; some males).

The adult of *Vermetus triquetrus* shows a tube whose internal averages diameter 4 mm and presents weak transverse growth lines. The superior keel, from which this species was named because it gives to the shell a triangular section, is evident and pronounced only in specimens from sheltered zones (Tab. 1), while it is not prominent or irregular in specimens from exposed coasts. It is practically absent in the feeding-tubes.

The colour of the shell is dirty-white, sometimes with longitudinal reddish-brown cords. The animal is yellowish-white with some small dark-brown spots (more or less evident) on the foot and near the cephalic tentacles.

The chitinous operculum is greenish-yellow, but sometimes it has the same colour of the foot, and is not so evident. It could be 1/5-1/6 of the diameter of the shell aperture.

Settling on opercula by polychaetes (Spirorbidae) and bryozoans was observed in spite of the reduced dimensions and position of the operculum.

The radula is shown in Fig. 2 (B). Radular data in Tab. 2. Juvenile shells, grown on bibulous paper, are illustrated in Fig. 2 (G-H).

From June to September about 40 samples of *Vermetus triquetrus* have

been examined. There were about 30 males and only 10 females; 3 of them were ovigerous. The recorded maximum number of egg capsules was 14.

*Vermetus (Thylaeodus) granulatus* (Gravenhorst, 1831)

Portofino Promontory (Ge) (6 September 1994) (5 males)

This species has an internal average diameter of the tube of 2 mm and a shell with 4-6 strongly granulated ridges, resulting from the erosion of the original sculpture, formed by a succession of strongly pronounced tile-shaped expansions. In the same specimen, the ridge may be more or less granulated. The colour of the shell is dark-brown. The animal appears mainly brown and presents near the mouth and on the edge of the mantle bright orange striae. The operculum is very small in comparison with the shell aperture (up to 1/8), even if, according to the subgenus features (KEEN, 1961), it should reach about 1/2. In some individuals an oval shape or very irregular edges have been observed. The spiral lamina, rising free from the disc of the operculum and characteristic of the subgenus, is little erect and can be seen only in samples with a perfect operculum. The radula is shown in Fig. 2 (A). Radular data in Tab. 2.

*Petalococonchus (Macrophragma) glomeratus* (L., 1758)

Pontetto (Ge), one dead individual (8 August 1994). 4 metres depth.

Only a shell was found of this species, not yet recorded in the Ligurian Sea (BEDULLI *et al.*, 1992). It is not eroded as it often occurs in the species belonging to this genus. CONTI & ROSSINI (1985) recorded the presence of *Vermetus spirintortus* (MONTEROSATO, 1892, fig. 1, fig 9), a probable synonym of *P. glomeratus*, in the coralligenous biocoenosis of the Portofino Promontory.

The diameter of the tube of the Pontetto specimen is 1,5 mm. The shell shows the typical symmetrical hollow cone arrangement, formed in this case by 5 1/2 coils. The internal cavity has a maximum diameter of 1,4 mm. The sculpture is formed by longitudinal and transversal threads, forming a relatively regular reticulum. The intersections form small nodules. No scars of abandoned feeding-tubes are visible. Only one small internal lamina protrudes from the columellar wall. The colour of the shell is light brown.

*Serpulorbis arenaria* (L., 1767)

Pontetto (Ge) 4 samples (from June to September 1994) (5 males).

Portofino Promontory (Ge) (6 Sep 1994) (1 female and 5 males).

Varigotti (Sv) (10 Aug 1994) (4 males).

The genus *Serpulorbis* is characterized by a shell of great dimension: the

individuals from the Ligurian coasts have an average shell diameter of 12 mm.

On average, each individual has one scar, evident for the dimension of the species. The specimens from shallow waters are yellowish-brown, while those found in deeper waters are whitish. The sculpture of the shell is constituted by very small granules forming thin parallel striae, running along the length of the tube. At the stereo-microscope, they show the "tile model" cited for *V. granulatus*, only smaller, flattened and regular in the spaces. Some individuals may present a ridge in the superior part of the tube which is present only in short tracts and never obvious. The animal, unmistakable for the colouring with the other species, is dark-red, with yellow or white spots on all the anterior portion of the body and of the mantle. The wide surface of the foot slightly hides the head. The operculum is absent. Among the 15 individuals of *Serpulorbis arenaria* examined, there were 14 males and only one non-ovigerous female. The rachidian tooth is shown in Fig 2 (C). Radular data in Tab 2.

## Discussion

The study of specimens of *Vermetus triquetrus*, *Vermetus granulatus*, *Serpulorbis arenaria* and *Petaloconchus glomeratus* from the Ligurian Sea has permitted their first investigation in these waters and an increase of knowledge of the Vermetidae family in the Mediterranean Sea. Particularly, the redescription of *Vermetus granulatus*, a species seldom recorded in the Mediterranean, allows a better definition of the shell features and gives data about its colour pattern and radular morphology.

From a taxonomic point of view, the radula, together with other characters, may allow a better specific classification, even in co-generic species (MORTON, 1951). In fact, in spite of the homogeneity of radular characters of the family (BANDEL, 1984), differences in the number of the flanking cusps of the first marginal tooth (Tab 2), and in the shape of the flanking cusps of the central tooth were found (Fig. 2, A-B). The second marginal tooth has an identical morphology.

The sessile mode of life places the Vermetidae among the more specialised groups of prosobranch molluscs (MORTON, 1955).

The shell usually tends to develop according to a spiral and sinistral model, but the conditions of the substratum, the direction of the hydrodynamic fluxes (HUGHES, 1979), and inter- and intraspecific competitions may result in considerable modifications of the form of the shell. In fact Vermetids have evolved the possibility to reorientate the shell aperture (more frequently the feeding-tube one), with shell removals operated by the radula and reconstructions of the margins; event testified by the scars of the old abandoned tubes (KEEN, 1961).

These modifications were observed in a Varigotti specimen of *Vermetus* sp., kept in a jar with the feeding tube oriented towards the bottom instead of the original erect position. In 12 days it was able to reconquer a favourable

trophic position (Tab 3, B1-B2).

In *V. triquetrus*, the first feeding-tube is formed immediately after the juvenile has surrounded the larval shell with the first coil, an event that coincides with the change of the growth angle axis to 90° (Fig. 2, E-F).

In the laboratory and in the absence of turbulence, juveniles have kept the first feeding-tube for three weeks, without producing any modification. Probably in nature, it is quickly destroyed and others are formed at a higher frequency. In fact, juveniles of *V. triquetrus* collected at Varigotti, under a stone, presented a high amount of scars that become less frequent with the age of the individual.

Contrary also to KEEN's (1961) statement, these scars are present even in the subgenus *Vermetus*, to which *V. triquetrus* belongs, but they are frequent only in juveniles.

Another observed modification was the construction of a lamellar expansion around a hole after a damage in the inferior part of the shell, that reduced the hole to a small fissure, instead of stopping it as in other cases (Fig. 3, A1-A2-A3-A4). The part of the shell remaining behind the hole was abandoned and all the trophic activities continued to be carried out through this fissure. Another similar structure was observed in a female of *V. triquetrus*. In fact, after the erosion of the edge of the shell that precedes the production of a new feeding-tube, probably because juveniles were settled near the edge, the process was interrupted, and two curved lamellae replaced the feeding-tube.

In samples of *V. triquetrus*, grown in sandy habitats, the shell can include sand grains (<1mm) (Fig. 2, D; Fig. 3, E).

The phenomena of occlusion of the shell aperture carried out by epibionts do not seem to influence the morphology and the growth of the shell. In *V. triquetrus*, the invasion of the inner part of the shell aperture carried out by encrusting algae and bryozoans, was limited by the action of the radula (Fig. 3, C-D).

Voucher material will be deposited in the Zoological Museum of the University of Bologna, Via Selmi, 3 I-40126, Bologna, Italy at the end of a more complete study about the taxonomy of the Mediterranean species. Moreover, exhaustive tables of the morphotypes of the all collected shells will be published in this work.

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Table 1. Dimensional values of some complete individuals (All the dimensions are in millimetres). *V. triquetrus* A from sheltered coast; *V. triquetrus* B from exposed coast.

	<i>V. triq. A</i>	<i>V. triq. B</i>	<i>V. gran.</i>	<i>P. glom.</i>	<i>S. aren.</i>
Internal max. shell diameter	4	2,8	2,1	1,3	8,5
Thickness of the feeding-tube	0,2	0,3	0,5	-	0,5
Thickness of the tube	-	-	-	0,6	-
Thickness of the ridge	1	0,6	0,7	-	-

Table 2. Radular data.

	<i>V. triq.</i>	<i>V. gran.</i>	<i>S. aren.</i>
FLANKING CUSPS (Central tooth)	3	2	3-4
INNER FLANKING CUSPS (Lateral tooth)	2	2	2
OUTER FLANKING CUSPS (Lateral tooth)	4	4	2-3
INNER FLANKING CUSPS (First marginal)	1	1	1
OUTER FLANKING CUSPS (First marginal)	3-4	1-2	2

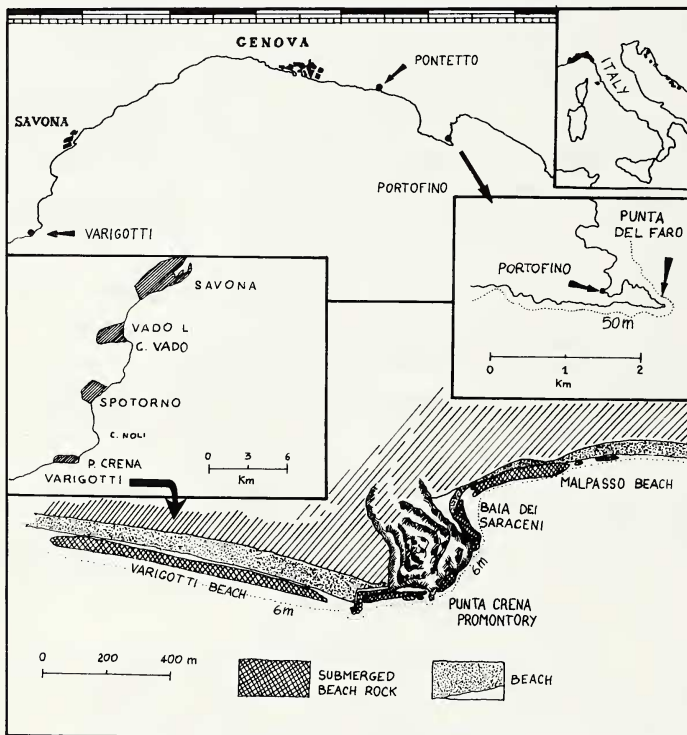


Figure 1. Maps of the sample locations.



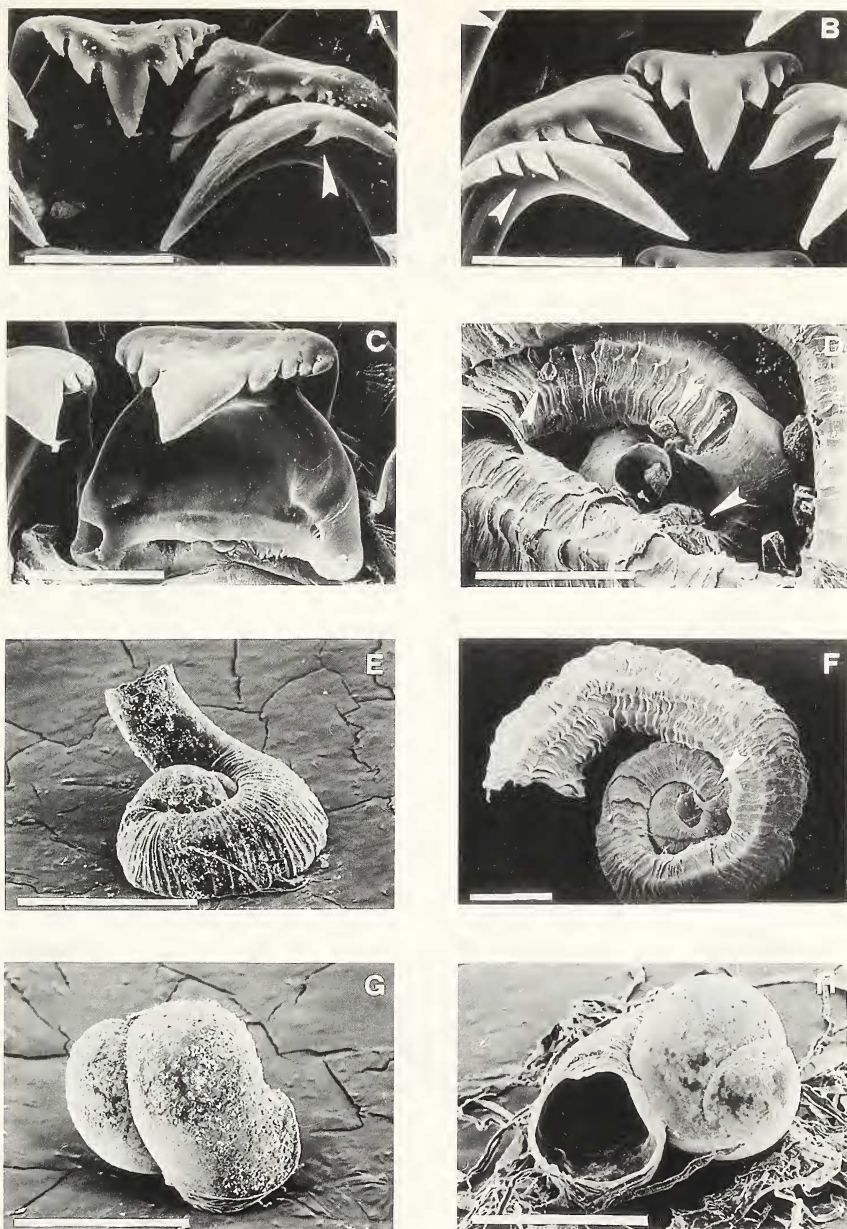


Figure 2. A : Radula of *V. granulatus* (scale bar: 0,05 mm). B : Radula of *V. triquetrus* (scale bar: 0.05 mm). C : Rachidian tooth of *S. arenaria* (scale bar: 0,1 mm). D : Inclusions of grains of sands (<1mm) in a juvenile of *V. triquetrus* (scale bar: 1 mm). E : Juvenile of *V. triquetrus* with the first feeding-tube. Note the completely absence of any ornamentation on the feeding-tube. (scale bar: 1 mm). F : Jounge specimen of *V. triquetrus* (scale bar: 1mm). The arrow shows the scar of the first feeding-tube. G : Embrio of *V. triquetrus* with a small portion of the teloconch (scale bar: 0.5mm). H : Juvenile of *V. triquetrus* grown on bibulous paper (scale bar: 0.5mm).

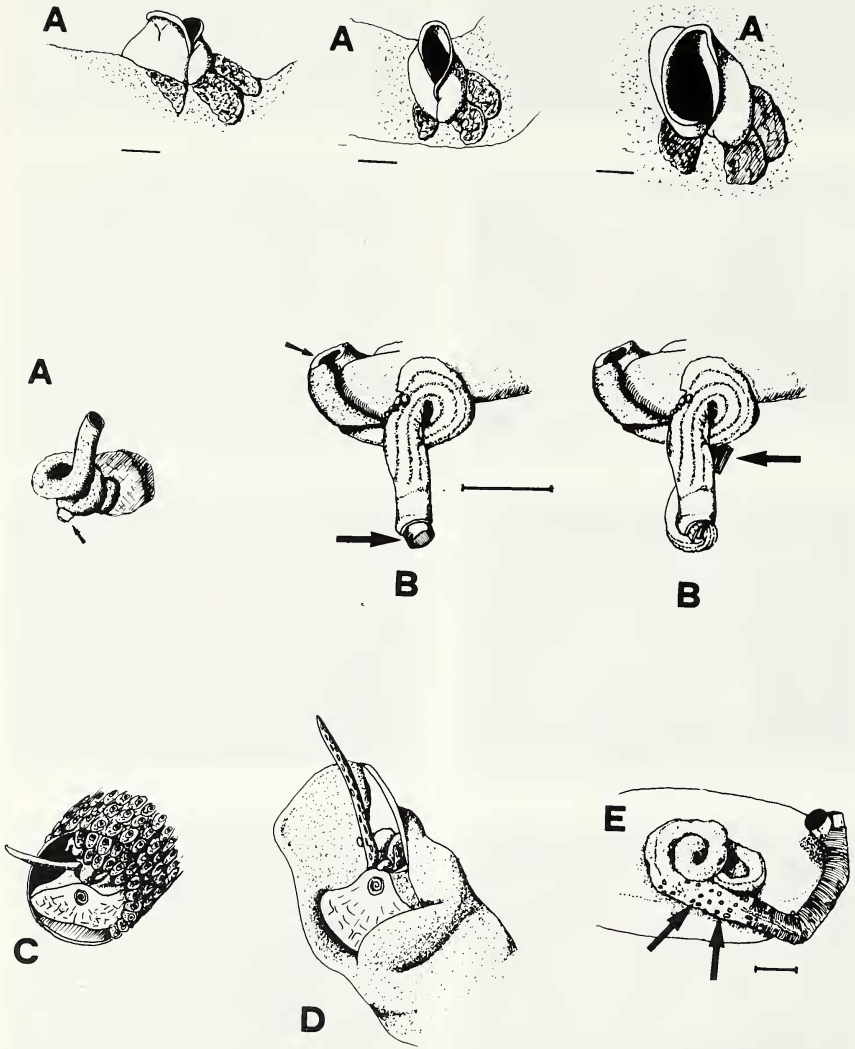


Figure 3. A1, A2, A3 : Some views of the fissure cited in the text (scale bar 1mm). A4 : Positions of the lamellae on the shell. B1 : Big arrow: starting point; small arrow: damaged old abandoned tube (scale bar: 5mm). B2 : Big arrow: the aperture after the modifications. (scale bar: 5mm). C : Invasion of the inner part of the shell aperture of a specimen of *V. triquetrus* carried out by Bryozoans. D : Invasion of the inner part of the shell aperture of a specimen of *V. triquetrus* carried out by encrusting algae. E : Inclusions of sand grains in an adult specimen of *V. triquetrus* (scale bar: 1 cm).